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COTTONMOUTH MOCCASIN OF FLORIDA

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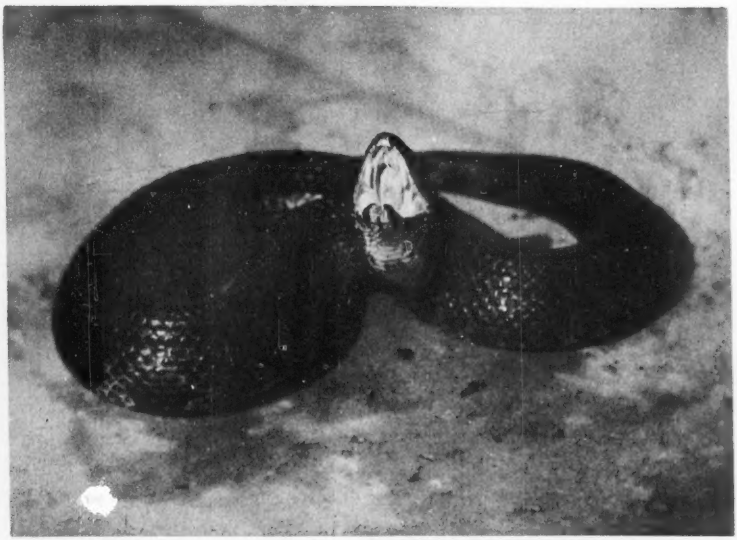
REPTILE INSTITUTE
SILVER SPRINGS, FLORIDA



COTTONMOUTH WATER MOCCASIN IN CHARACTERISTIC, THREATENING POSE. 1937
Photo by Ross Allen

This Supplement donated to current Members of the Herpetologists League by Mr. E. Ross Allen.—Ed.

COTTONMOUTH MOCCASIN SUSPENDED BY TAIL FROM SMOOTH STICK.
SHOWING THAT TAIL IS PREHENSILE.

THE COTTONMOUTH MOCCASIN OF FLORIDA

By E. Ross Allen and David Swindell

REPTILE INSTITUTE, SILVER SPRINGS, FLORIDA

The following report represents observations of moccasins both in captivity and in the wild over the state from 1933 to 1946.

RANGE: The cottonmouth moccasin, *Agkistrodon piscivorus piscivorus* (Lacepede), is found in every county of the State of Florida and many islands of the coastal areas. Salt water is not a barrier to the wandering of these snakes.

GENERAL APPEARANCE: Moccasins are difficult to describe except in a general way because of so many variations in color and pattern. They are stout and dull colored with broad, thick heads. Keeled scales give the rough, dull appearance. The dorsal pattern varies in shape from irregular diamond blotches to irregular bands, while the color of the blotches may vary from dark brownish-green, or a coppery color in the case of juveniles, to almost black. The background may vary from tan to olive-green. The ventral pattern is also irregular, with the blotches somewhat smaller than those on the back which gives the appearance of a more extensive background. These blotches are usually staggered and extend from approximately the center of the belly toward the ends of the ventral scales. They also tend to merge increasingly in the posterior third of the body. Moccasins with the background color only, without pattern, are commonly found. The colors and patterns of juveniles are extremely vivid, fading with age so that the pattern on an old snake may be hardly distinguishable. The color may be a solid gray-black.

The color, shape and position of the blotches vary considerably. Occasionally individual moccasins are found with unusual markings. On August 8, 1938 a brood of eleven were born at the Reptile Institute, three of which had two longitudinal stripes instead of the regular transverse markings.

IDENTIFICATION CHARACTERS FOR LAYMAN: Moccasins belong to the family of "pit vipers." There is a pit similar to a nostril opening located about half-way between the nostril and the eye, said to serve in detecting the proximity of warm blooded animals. This snake has an elongated, triangular-shaped head with a broad, thick snout. The eyes are located on the side of the head and the pupil is vertically elliptical rather than round as are those of *non-poisonous water snakes*. The eyes are covered from above by the eye shields which prevent the observer from seeing the eyes when viewed from above.

The body color patterns vary so much that the novice should ignore them completely in identification. The head pattern is fairly constant. The under part of the chin is light colored with several dark slots along the lower lips on either side. The upper lip is slightly darker, with a light stripe above it. A dark stripe passes between the eye and the back of the jaw, giving a rather masked appearance.

The fangs are located in the upper jaw just beneath the pit. They are more than twice the length of the teeth and separate from them. These paired fangs fold against the roof of the mouth when closed.

The snake characteristically rests, crawls and swims with the head raised at an angle of 45 degrees.

VISION: The moccasin can detect movement for a distance of at least fifty feet. The eyes are capable of slight forward rotation and, to a lesser extent, backward. Limited downward vision is attained by rotating the eye. Due to the overhanging supraocular scale, the snake is incapable of direct upward vision.

DIMENSIONS: The cottonmouth moccasin ranks as one of the largest poisonous snakes. The largest specimen of which we have a record, a male, measured 72 inhces in length and weighed 10 pounds 2 ounces. This snake was cought in Marion County.

The following is a summary of the results of the examination of 221 snakes of which 125 were males and 96 females. Males: The two largest ones were each 68 inches in total length, one weighing 8 pounds 1 ounce, with a tail 8 inches in length; the other weighing 9 pounds with a 10½ inch tail. There is considerable variation in the tail lengths among snakes of the same size. Female: The largest of the series was 49 inches in length and weighed 4 pounds. The tail measured 8½ inches.

SCALE COUNTS: Scale counts on 22 snakes from Marion, DeSoto and Gulf Counties: ventrals 136 to 143; caudals 45 to 51; rows at neck 25 to 27; midbody 25; one inch anterior to vent, 21 to 23.

NUMBER OF LIVE MOCCASINS COLLECTED IN FLORIDA BY THE REPTILE INSTITUTE 1933--56; 1934--174; 1935--342; 1936--835; 1938--958; 1939--802; 1940--928; 1941--1745; 1942--2175; 1943--3353; 1944--1162; 1945--2673; Total 15,203.

HABITS: Moccasins live in or near water in which they obtain most of their food, but seem to prefer a retreat nearby for safety and warmth. In the Everglades, the snakes are frequently found in clumps of palmettos as much as a quarter mile from water. Open water is no barrier and they may be found on coastal islands of the gulf more than a mile from shore. On these islands, where fresh water is not available, it is believed that the snakes depend on dew and rain as experiments have shown that they will not drink salt water.

During the cooler months they may be seen basking in the sun, usually in the early part of the day and they occasionally lie in tree branches over or near water. Moccasins are fair climbers where there are protruding edges or branches on which to secure a purchase. The tail is prehensile and in descending, they frequently employ it to hold to branches. Moccasins are very abundant in certain localities and their adaptability permits them to survive where other species perish. Twelve large ones were taken on a section of old washout tram road which was thickly overgrown with blackberry and cane at the edge of Orange Lake in Marion County. In a cypress swamp in Hendry County, seventeen large snakes were taken in a fifty yard radius. It appears to be most active at night in hot weather; morning and evening in cool weather.

FOOD: This is one of the few snakes which does not seem to be particular about its food. They eat great varieties of live food and will take carrion without hesitation. An astonishing variety of stomach contents was found in captured snakes which regurgitated their

meals due to handling. Records show the food included other moccasins, prarie rattlesnakes, king snakes, black snakes, water snakes, garter snakes, ribbon snakes and horn snakes. In one instance, a captive moccasin swallowed a brown water snake six inches longer and a half pound heavier than itself. After this gluttonous meal the moccasin was unable to crawl and died the next day. Other items on the list include most of the species of frogs, baby alligators, mice, rats, guinea pigs, young rabbits, birds, bats, squirrels and lizards. The senior author has a record of one eating a mud turtle *(Sternotherus odoratus)*. A collector reported a case of a four footer eating ten to twelve chicken eggs. Moccasins have also been found with heron eggs in their stomachs.

The most common food appears to be fish and frogs. Catfish are included on this list and the snakes are sometimes fatally injured by the spines of the fins. One specimen was kept in captivity for more than a month with a spine protruding from its neck just behind the head. The fish had been digested and the wound healed over so that the spine did not appear to cause the snake any discomfort. Probably most of the fish eaten are caught in shallow water or by cornering them against the bank and under logs. When ponds dry up, moccasins congregate and gorge themselves on the dying fish until they can hold no more. They usually stay nearby as long as the food remains.

Moccasins in captivity have been observed to trail a fish dragged across the pen floor by carefully smelling and rubbing their lips on the track. Those in captivity are chiefly fed on fish. The moccasins usually live amicably with other snakes, but may suddenly begin to eat them even when there is an abundance of fish present. Occasionally two snakes will seize the same fish or frog and in several instances this has resulted in one snake swallowing both the food and the other snake as well.

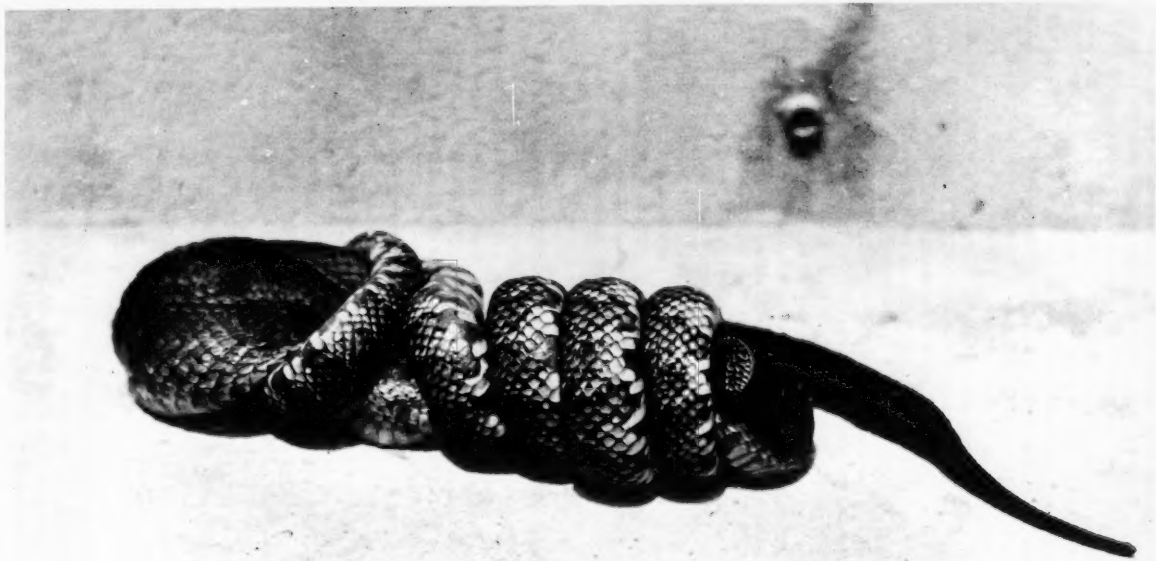
HOW FOOD IS OBTAINED: It appears that moccasin fangs, being short, were developed principally for obtaining furless and featherless foods, such as frogs and fish. The fangs are shorter and straighter than those of a rattlesnake. When a moccasin catches a fish or a frog, he hangs on, injecting venom, sometimes swallowing the pray before it is dead.

When feeding on mice, the moccasin strikes and retains his hold. However, if the mouse bites at the snake, it is dropped and the snake waits until it succumbs. When killing larger rodents, they timidly strike as though afraid and await the animal's death before eating.

A resting, hungry moccasin quickly becomes alert when a mouse walks past, detecting the mouse either by smell or sight. The snake stretches out to investigate, following the mouse with his head only a few inches away. When sure, it strikes quickly. If poisonous snakes were as deliberate in aggressively striking a person as they are in feeding, they would be very dangerous indeed.

During the spring and early fall the snakes seem to feed primarily between daylight to 9:30 A.M., and 4:30 P.M. to dark. During hot summer weather, feeding is done chiefly at night. The search for food is conducted on both land and water. They feed when the temperature exceeds 65 degrees. Several warm days in early spring are usually required for moccasins to start feeding.

BEHAVIOR: The name "cottonmouth" is derived from the characteristic action when disturbed of holding the mouth wide open, displaying the fangs and white lining of the mouth in a threatening manner. The head is thrown back and upward at a sharp angle, very tensely, sometimes



KING SNAKE KILLING A COTTONMOUTH WATER MOCCASIN, WHICH THEY APPARENTLY DO NOT EAT. APRIL 14, 1937

Photo by Ross Allen

jerking nervously up and down. This pose is more commonly observed when a snake is coiled, but may be seen occasionally when it is stretched out. This threatening action is more frequently seen in cold weather than during the warmer months. Peculiarly enough, they do not always bite from this open mouth position when offered an opportunity. On some occasions they bite viciously, while at others they refuse even when objects are thrust into their open mouths.

When a moccasin is annoyed it will often switch its tail back and forth and occasionally will vibrate its tail so rapidly against the ground as to cause considerable noise.

This snake often squirts musk as another defensive action. The musk comes from glands located on either side of the vent and is squirted upward for a distance of as much as five feet. The musk is yellow in color with an acrid odor, offensive enough to assist in keeping intruders away. The action of squirting musk is more frequently observed during cold weather.

Moccasins can bite under water and will coil and strike while floating on the surface as well as under water. They bite very rapidly and repeatedly in a chewing manner, occasionally hanging on after biting. They have been observed to bite over the side of the lower lip. In "milking" the snakes to obtain their venom one sometimes may be seen to bite furiously and repeatedly at the dish. The biting is often done by a single fang at a time, alternating fangs with each other.

On rare occasions, moccasins are found which will attack. One three footer, when approached, struck upward so hard that he lifted his body off the ground. He advanced, coiling and striking repeatedly, following the retreat of the observer. Others have been seen to charge deliberately with open mouth. Most attackers seem to do so in a bluffing manner rather than in vicious pursuit.

Moccasins are unpredictable and so variable in their moods as to be thoroughly undependable. A perfectly docile snake will turn and bite viciously without any apparent reason. Snakes which fight wildly on being captured seem to become quickly accustomed to captivity and soon become so docile as to permit careful handling. However, these same docile snakes will suddenly turn and bite without cause. The senior author saw one moccasin which was so tame that he was allowed the freedom of the house, sleeping under the bed and regularly feeding from a dish. The snake seemed to recognize his master and enjoyed coiling in his lap and being rubbed on the head. This snake was kept in this manner for six years, until its death.

LOCOMOTION: Moccasins usually crawl by undulating curves, but they are capable of rib-walking straight forward, without curving the body. This movement is slow and stately, often with the head held high. When in a hurry the snakes fairly thresh along, often seeming to leap part of their length in their haste.

When swimming, they travel along the surface with the head held high, whipping the water with their bodies. They are not as expert under water as *Natrix*, but when disturbed they may dive and even burrow down into the mud.

SHEDDING: Moccasins shed the outer skin about four to six times a year, according to speed of growth, which is determined by weather and food. When snakes are ill or have irritations on their skin, they shed more frequently; sometimes in immediate succession.

One snake under observation began the shedding process on August 4. The eye shields turned opaque and remained so for three days after

COTTONMOUTH WATER MOCCASINS SHOWING AGE VARIATIONS.

COTTONMOUTH WATER MOCCASINS AROUND DRYING WATER HOLE IN THE EVERGLADES, HENDRY COUNTY. APRIL 10, 1946

Photo by George Marhout

DEMONSTRATION OF A COTTONMOUTH WATER MOCCASIN BITING UNDER WATER.

which they cleared but the skin remained rough and dull in appearance. On the 8th the snake was observed to be attempting to loosen the skin by rubbing its head against the water pan in the cage. These attempts continued through the next day. The shedding was completed during the night of the 9th.

The following observations of a dance between two four-foot moccasins were made on the morning of September 23, 1945.

The dance began at 7 A.M. with the one snake crawling over the other. They reared into the air, constantly weaving and twisting themselves against and around each other. One crawled slowly along with the other closely following. The two pressed their bodies against each other so hard when they slipped the force of the pressure would carry their bodies far apart. The weaving and twining continued. The other snakes in the pen paid no attention, although some of the action occurred while crawling over them. Several times the smaller one escaped and then a chase ensued. When it became necessary for the larger to cross the other snakes in his pursuit, he hesitated slightly to investigate before continuing the chase. It appeared that they depended upon scent for identification. The dance was continuing at 9 A.M. when the observer was forced to leave. The behavior was still in progress when it was checked at noon. Investigation at 2 P.M. found the activity at an end.

COPULATION: On October 19, 1946 a pair of moccasins copulated in the snake pen at the Reptile Institute. They were discovered after copulation had begun and the snakes remained copulating for three hours. During the time they were photographed, moved about and even lifted from the floor without apparent disturbance to the snakes.

BIRTH RECORDS: We have records of twelve broods born in captivity, all of which were born during the months of August and September. The number in the litters ranged from four to eleven. The following observations were made of one typical brood, six snakes in the litter, three of which were born dead. One measured: total length 13 inches, tail 2½ inches, weight 1 ounce, fangs and teeth present.

ADULT SNAKES WITH EMBRYOS: Captured May 7, 1946 in the Everglades

TOTAL LENGTH	NO. EMBRYOS	TOTAL LENGTH	NO. EMBRYOS
44 inches	11	36 inches	8
42 inches	8	36 inches	5
40 inches	8	36 inches	6
39 inches	10	35 inches	6
39 inches	11	33 inches	4
39 inches	10	33 inches	5
38 inches	10	33 inches	6
38 inches	7	32 inches	5
38 inches	7	30 inches	4
37 inches	8	29 inches	5
37 inches	6	28 inches	3
37 inches	7	28 inches	4
37 inches	12	28 inches	4
37 inches	5	27 inches	5
36 inches	6	27 inches	3
		26 inches	4

ENEMIES: Moccasins seem to have many enemies. Herons and cranes eat the young, and snapping turtles and alligators account for a small percentage. Horned owls, hawks and eagles have been observed to catch them. It is generally believed that wild hogs eat them, but of this we have no absolute proof. Moccasins are cannibalistic.

The senior author's tame American eagle once flew into the snake pit and caught a three foot moccasin which he killed and ate, without harm to himself.

A very unusual mishap took place near Ocala when a blue heron was killed by a moccasin. The heron drove his bill all the way through the moccasin's head and the moccasin wrapped itself around the bird's neck. The witness said the heron tried to shake off the snake but was soon choked to death.

PARASITES AND DISEASES:

1. An infection commonly called *"Canker Mouth"* is indicated by swollen head and throat, redness near center of infection, and difficulty in breathing, is caused by injury or bruises among captive snakes with diet deficiency.
2. *Tuberculosis* is found in wild snakes, and also many captive specimens die of that disease.
3. *Osteomyelitis* is caused by injury to bones or teeth and spreads rapidly on poorly fed, captive snakes.
4. *Pneumonia* occurs in wild and captive snakes and is usually fatal. It is very difficult to treat.
5. *Tumors* are frequently found on snakes. Most of the snakes appear to remain healthy in spite of tumors.
6. *Ulcers* and local abscesses occur--also an unnamed infection that causes tiny nodules on the body. The infection is usually fatal in captivity, but snakes which have been marked and released, have been returned fully recovered.
7. Old moccasins that were dissected showed lesions in lungs and chirrosis of the liver.
8. Moccasins also are subject to external parasites, red bugs, mites and ticks.
9. Moccasins have several varieties of internal parasites, lung worms, as well as intestinal worms.

Some moccasins captured in the woods are so poor and weak from parasitic infection that they can barely crawl. They usually have a dry, pale skin and are so thin that their backbones show.

FANGS: Moccasins have at least one primary fang and four or five secondary fangs that are in process of developing. They shed fangs regularly, the new ones appearing before the old ones drop out. Usually the fangs are replaced one side at a time, alternately. The replacement of the fang takes about five days and during that time venom is ejected through both fangs, or the old or the new, depending on the stage of replacement. This interesting process was discovered while milking and checking thirty odd moccasins with double fangs.

RECORD OF FANG SHEDDING: On July 7, 1946 a specimen had two fangs on the left side and one on the right. From July 9 to July 28 it had one on each side. On August 4 the eyes turned opaque and two fangs were present on the right side. On the 6th the eyes were clear and skin was shed on the 8th. On the 10th one fang was again present on each side.

MEASUREMENTS OF TYPICAL SNAKES AND THEIR FANGS, MEASURED IN INCHES

SEX	TOTAL LENGTH	TAIL LENGTH	WEIGHT	DISTANCE APART AT BASE OF FANGS	LENGTH OF FANG
M	62¼	9½	8 lbs. 3 oz.	7/8	3/8
M	52	8½	4½ lbs.	3/4	5/16
M	42½	7	2 lbs. 9 oz.	7/8	1/4
F	39½	6	2 lbs. 1 oz.	7/8	1/4
F	38	5½	2 lbs.	13/16	5/16
F	32¼	5	1 lb. 10 oz.	5/8	1/4

VENOM GLAND: The venom gland is located just posterior to the eye and proximal to it. The gland is partially covered by muscles inserting on it dorsally. Ventrally the gland is very close to the roof of the mouth. At the posterior angle of the jaw the gland is covered only by the mucosal lining. The duct leaves the gland below the eye and extends forward along the lower side of the eye, thus passing along the upper lip beneath the eye and pit. It passes forward over the outer surface of the maxillary and ends in a tight fitting membranous cap over the anterior basal portion of the maxillary bone and fangs. This cap is separate and distinct from the fang sheath which seems to be a fold of the mucosal lining.

When a moccasin ejects venom into the milking dish perfectly, the venom squirts out in two thin streams which cross each other at about two inches from the fangs. On one occasion while "milking" a snake, the venom squirted outside of the snake's mouth, directly from the venom duct, instead of through the fang.

VENOM: Moccasin venom is of the haematoxic type, causing destruction of red blood cells and coagulation around the site of the bite. It rates third in potency, compared drop for drop to that of the coral snake and the eastern diamond-back rattlesnake. The venom is employed medically in the treatment of haemorrhagic conditions and rheumatoid arthritis, as well as in the preparation of antivenin.

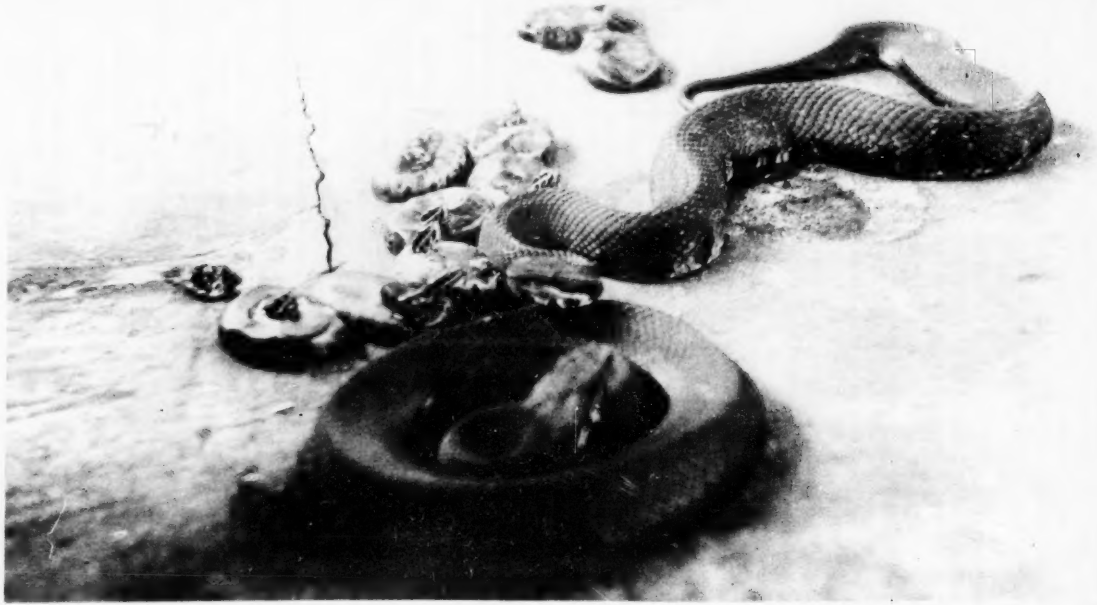
Moccasins frequently bite each other while being handled. The bite shows definite effects of poisoning, causing swelling and discoloration under the skin. Following the bite, the snakes become sluggish for several days and a small percentage die. It has partial immunity to its own venom but a large dose will cause death.

It is evident from the reports of snake bites that moccasins do not inject very much venom at a bite. The average moccasin yields 0.8 cc of venom on being "milked." The largest yield from an individual was 2.5 cc produced by a five foot specimen.

By allowing snakes to bite at the edge of a thick dish a single time and then drying the venom in a dessicator, the following results were obtained: 26 inch snake, 10 mg dried venom; 36 inch, 30 mg; 39 inch, 70 mg; 56 inch, 20 mg.

These results show great variation in amount of venom injected at a bite and are below the lethal dose for man. Dried fresh moccasin venom tested in our laboratory on young, white rats of the Purdue Colony showed lethal dose to be 23 to 29 milligrams per kilogram of body weight.

It has been observed many times while "milking" snakes that large, old moccasins do not have as much venom as smaller ones. Eleven baby moccasins one week old, weighing a total of 12 ounces, yielded 1.5 cc



BROOD OF NINE COTTONMOUTH WATER MOCCASINS, PHOTOGRAPHED AFTER BIRTH, BEFORE SNAKES CRAWLED OUT OF EMBRYONIC SACK.
OCTOBER 1946

Photo by Celeste T. Roess

of venom. This venom was colorless and when tested was found to be more potant than that of adult snakes.

The following record of moccasin bites for Florida was compiled from newspaper accounts and from records of the Bureau of Vital Statistics: Beginning in 1934 there were 8 cases of bites resulting in 3 fatalities. From that date to 1944 there were no fatalities recorded. The number of cases for each year are: 1935, 10; 1936, 16; 1937, 7; 1938, 6; 1939, 5; 1940, 3; 1941, 6; 1942, 3; 1943, 1 and 1944, 3.

Our records show that fifty per cent of moccasin bites result in crippled fingers or toes, due to gangrene which usually sets in as a result of coagulation, destruction of red corpuscles and strangulation of blood vessels.

SELECTED LITERATURE ON MOCCASINS

Anderson, Paul
1941 The Cottonmouth In Northern Missouri
Copeia, No. 3 p. 178

Allen, E. Ross
1937 Florida Snake Venom Experiments
Florida Academy Of Science, Vol. 2

Carr, A. F. Jr. and M. H. Carr
1942 Notes On The Courtship Of The Cottonmouth Moccasin
Proceedings of the New England Zoological Club, July 18

Carr, A. F. Jr.
1936 The Gulf-Island Cottonmouths
Proceedings of the Florida Academy of Sciences, Vol. 1

Cochran, Doris M.
1943 Poisonous Reptiles Of The World
The Smithsonian Institution, City of Washington, March 19

Conant, Roger
1933 Three Generations Of Cottonmouths
Copeia, No. 1 Apr. 3

Conant, Roger
1934 Two Rattlesnakes Killed By A Cottonmouth
Science, Vol. 80 No. 2078 p. 382 Oct. 26

Conant, Roger and William Bridges
1939 What Snake Is That?
D. Appleton-Century Company, New York P. 140-141

Ditmars, Raymond L.
1936 The Reptiles Of North America
Doubleday, Doran & Co.Inc., Garden City, New York p. 164/166

Gloyd, Howard K. and Roger Conant
1943 A Synopsis Of The American Forms of Agkistrodon (Copperheads and Moccasins)
Bulletin Of The Chicago Acadamy Of Sciences

Neill, Wilfred T.
1947 Size and Habits of the Cottonmouth Moccasin
Herpetologica, Vol. 3

Pope, Clifford H.
1944 The Poisonous Snakes Of The New World
New York Zoological Society, New York p. 19

Schmidt, Karl P. and D. Dwight Davis
1941 Field Book Of Snakes Of The United States and Canada
G. P. Putman's Sons, New York p. 285-286

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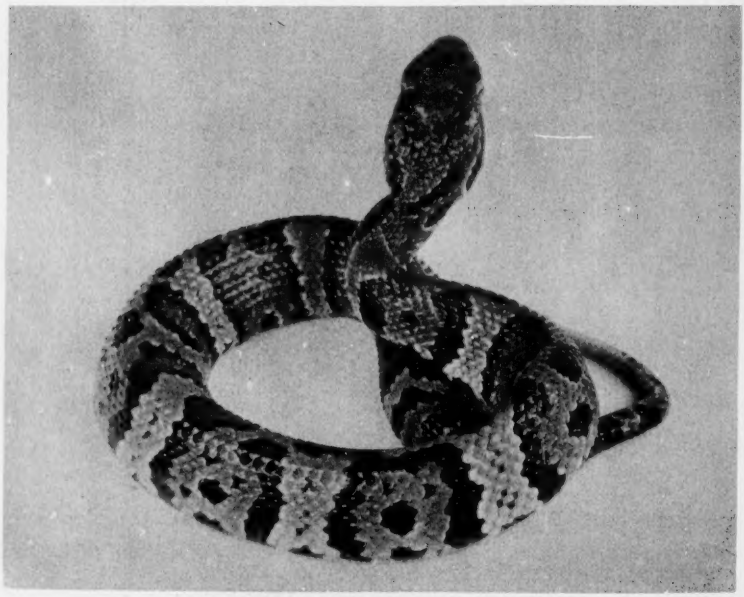

BABY COTTONMOUTH WATER MOCCASIN FROM SILVER SPRINGS, FLORIDA.
SEPTEMBER 1937